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Prior Term Birth Weight: Is It Useful for Predicting Fetal Weight in Subsequent Pregnancies?

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Abstract

Objectives: To investigate the relationship between birth weights in successive pregnancies.
Methods: Successive, full-term pregnancies were examined in 54 non-diabetic, non-hypertensive women. Birth weights in prior pregnancies were used to predict subsequent birth weights, both alone and after correcting for differences in gestational age and fetal gender between the two pregnancies.
Results: Prior birth weight predicted subsequent birth weight with a correlation of 0.39 and a mean absolute prediction error of ±330 g (±9.6%). Correcting for changes in gestational age and fetal gender increased the correlation to 0.51 and reduced the mean absolute prediction error to ±291 g (±8.4%).
Conclusions: Term birth weight in multiparous women can be predicted to within ±291 g (±8.4%) using only prior birth weight and two other variables that describe the current and preceding pregnancies. This routinely available information may explain why mothers can estimate the birth weights of their current fetuses with reasonable accuracy.

INTRODUCTION

Recently, it has been reported that pregnant women are able to predict the birth weight of their offspring with an accuracy ranging from ±305-402 g (±8.7-11.5%) at term. [1,2,3,4,5] By contrast, obstetrician's abilities to predict birth weight using clinical palpation have ranged between ±277-336 g (±7.5-10.3%), [1,2,3,4,5,6,7,8,9] and when obstetrical ultrasonography is employed, it's accuracy has ranged between ±285-564 g (±8.2-15.6%) in the same and similar studies. [3,4,5,6,7,8,9]

This study was undertaken to examine the paired birth weights of term offspring born to non-diabetic, non-hypertensive women who had two deliveries within a four-year period at a single academic institution in the United States. In addition, a prediction model was developed for estimating term fetal weight based on a combination of factors during the current and prior pregnancies to address the question of whether multiparous women can make birth weight estimations based on the integration of routinely available pregnancy-specific information that can also potentially be used by clinicians.

SUBJECTS AND METHODS

The women included for study were delivered between August 1998 and April 2001 by one of the general obstetrical faculty practices within the Duke University Health System. All subjects were delivered at Duke University Hospital (elevation 106 m) and all were private patients. Approximately 700 women were delivered by this group during this period. Sixty-one of these women had term deliveries between 37-42 weeks of gestation and were also identified as having prior term deliveries at Duke University Hospital. The medical records of these patients were reviewed retrospectively to extract the following information for both pregnancies: maternal age, gravidity, parity, pre-pregnancy weight, final pregnancy weight, 50-g 1-hr glucose screening test result, 100-g 3-hr glucose tolerance test results (when necessary), medical illnesses, complications of pregnancy, fetal gender, birth weight, all standard pregnancy dating criteria, and maternal height and race.

This study made use of archival, de-identified patient information that was obtained before 2003. The study was retrospective in nature and had no impact on either the routine clinical care that was provided or to the type of information that was gathered. Thus, it conforms to the standards established by the NHMRC for ethical quality review [10] and was exempted from institutional review board evaluation.

During their prior pregnancies, two patients were diagnosed with gestational diabetes. Both were eliminated from further analysis due to the significant and highly variable effect of this condition on fetal weight. [11] Two additional patients were diagnosed with mild pre-eclampsia (1 in a prior and 1 in a subsequent pregnancy), and three others were diagnosed with chronic hypertension (2 in a prior and 1 in a subsequent pregnancy). These five patients were also eliminated from analysis, because these conditions can have a negative impact on fetal weight gain. [12,13] Remaining for analysis were 54 paired term singleton pregnancies (108 newborns) that were delivered to non-diabetic, non-hypertensive mothers. The demographic characteristics of the patients included for study are presented in Table 1.

Figure 1

Table 1: Demographic characteristics (mean ±SD) of 54 mothers in prior and subsequent pregnancies

Characteristic	Prior pregnancy	Subsequent pregnancy	p-value for difference
Maternal Age (yr)	30.8 ±3.3	33.0 ±3.4	< 0.001
Parity (after delivery)	1.1 ±0.5	2.1 ±0.5	< 0.001
Maternal Pre-Pregnant Weight (kg)†	64.7 ±14.9	67.4 ±17.7	0.001
Maternal Pre-Pregnant Body Mass Index (kg/m²)† ‡	23.4 ±5.2	24.4 ±6.4	0.002
Final Maternal Weight Prior to Delivery (kg)	79.9 ±15.2	80.1 ±15.7	n.s.
Total Maternal Pregnancy Weight Gain (kg)†	15.5 ±3.5	13.1 ±4.6	< 0.001
3rd-Trimester Glucose Screening Test Value (mg/dl)	104 ±20	103 ±20	n.s.
Gestational Age at Delivery (weeks)	39.7 ±1.2	39.3 ±1.0	0.042
Birth Weight (g)	3491 ±414	3493 ±368	n.s.
% of Term Newborns Weighing >4,000 g	13.0%	5.6%	n.s.
% Male Fetuses	56%	41%	n.s.
% Vaginal Deliveries	79%	81%	n.s.

† N = 52; pre-pregnant weight was not recorded for 2 mothers
‡ Maternal Height (mean ±SD) = 166.1 ±6.0 cm
n.s. = not statistically significant at the $\alpha = 0.05$ level

To assess the utility of prior birth weight for predicting the birth weight in a subsequent pregnancy, we began by using the prior birth weight as an estimate of the subsequent one. On average, birth weight increased by 2 g from prior to subsequent pregnancies across all 54 mothers. Since term birth weight is known to increase predictably as a function of advancing gestational age, we adjusted the prior birth weights by 12.7 g per day to accommodate for differences between the gestational age at delivery of prior and subsequent pregnancies. [14] Similarly, since term male fetuses are known to be heavier than females when matched for gestational age, we adjusted the prior birth weight by 136 g if there was a difference between the genders of prior and subsequent newborns. [15,16,17] Finally, the two adjustments were combined to simultaneously correct for differences in gestational age and fetal gender at delivery.

The accuracy of each estimation method was assessed by determining the correlation between the actual birth weight in the subsequent pregnancy and the birth weight that was estimated from the prior birth weight, both adjusted and unadjusted. We also calculated the difference between the actual and predicted birth weights and determined the mean of these differences. This is often referred to as the “systematic” error, as it represents the tendency to consistently overestimate birth weight (if the mean is a negative value) or underestimate birth weight (if the mean is a positive value). Additionally, we calculated the standard deviation of the difference between the actual and predicted birth weights. This is referred to as “random” error because – unlike the systematic error, which is assumed to be the same in all cases – it reflects the degree to which the accuracy of the birth weight predictions tends to vary from one newborn to the next. Another measure of predictive accuracy was also calculated by taking the mean of the absolute value of the differences between each actual and predicted birth weight, which is referred to as the “absolute” error. Finally, we determined the fraction of subsequent newborns whose estimated birth weight was within ±10% of their actual birth weight. Statistical comparisons between prior and subsequent pregnancies were made using t-tests or McNemar's tests.

RESULTS

All 108 pregnancies retained for analysis were delivered between 37-42 weeks of gestation. The racial distribution of the mothers was 83% Caucasian, 7% Black, 4% Oriental, and 6% other racial groups.

All prior and subsequent pregnancies had obstetrical ultrasonography performed to confirm the patient's last menstrual period dating. The mean gestational age at which confirmatory ultrasonic dating was performed was 15.0 ±4.5 weeks in prior pregnancies and 11.7 ±4.7 weeks in subsequent ones. In prior pregnancies, subjects had their gestational dating modified 19% of the time due to inconsistencies between their last menstrual period dating and ultrasonic dating criteria. [18] In subsequent pregnancies, 26% had their gestational dating modified for this reason.

The mean latency between deliveries was 2.3 ±0.7 years (range 1.3-4.0 years). The mothers weighed an average of 2.7 kg less at the beginning of their prior pregnancies than in subsequent ones. However, their weight at delivery was comparable between pregnancies, because the mothers gained an average of 2.5 kg more during their prior than their subsequent pregnancies (Table 1). On average, the newborn weight for subsequent pregnancies was 2 g greater than for the earlier offspring in same mothers, but this difference was not statistically significant. Mean early third-trimester 50-g 1-hr glucose screening test results were not significantly different for the prior and subsequent pregnancies (mean difference 1.3 mg/dl). The overall rate of fetal macrosomia (birth weight >4,000 g) was 9.2% and it was not statistically different in prior and subsequent pregnancies. The mothers delivered an average of 0.4 weeks later in their prior pregnancies than in their subsequent ones ($p = 0.042$), but the correlation between the gestational age at delivery of prior and subsequent term pregnancies was 0.23 and did not reach statistical significance.

The vaginal delivery rate was 79% in prior pregnancies and 81% in subsequent ones. Prior to their subsequent pregnancies, 89% of mothers had one prior delivery, 7% had two deliveries, and 4% had three deliveries.

The correlation between prior and subsequent term birth weight was 0.39 (Table 2), indicating that prior term birth weight could account for 15% of the unadjusted variance in subsequent term birth weights. The correlation increased when adjustments were made for differences in gestational age between deliveries or for fetal gender differences. The maximum correlation, which was attained by adjusting simultaneously for differences in gestational age and fetal gender between pregnancies, was 0.51, indicating that the adjusted prior birth weight accounted for 26% of the variance in subsequent birth weight.

Figure 2

Table 2: Accuracy of predicting subsequent birth weight from adjustments to the prior birth weight for 54 patients

Adjustment	Correlation with actual birth weight	Mean prediction error	SD of prediction error	Mean of absolute values of prediction errors	Percent of predictions accurate to within ±10%
No adjustment	0.39	2 g	434 g	330 g (9.6%)	61%
Adjusted for gestational age difference (±12.7 g/day)	0.50	40 g	370 g	291 g (8.4%)	69%
Adjusted for fetal gender difference (±136 g)	0.40	22 g	425 g	329 g (9.5%)	63%
Adjusted for gestational age and fetal gender differences	0.51	60 g	360 g	291 g (8.4%)	70%

A similar pattern was observed for both the random and the absolute errors (regardless of whether the absolute errors were expressed in grams or as a percentage of the actual birth weight of subsequent pregnancies). As the adjustments became increasingly more comprehensive, the random error (the standard deviation of the prediction errors) and the mean absolute error both declined in magnitude, reflecting increasing predictive accuracy. The random and absolute prediction errors were smallest when the birth weight predictions for subsequent pregnancies were based on the prior birth weight adjusted for both gestational age and fetal gender differences. When these adjustments were made, 70% of subsequent newborns had their birth weight predicted accurately to within 10% of their actual birth weight.

DISCUSSION

At least six different methods have been advocated for predicting birth weight. In addition to the present method that bases birth weight predictions for multiparous women on current and prior pregnancy-specific factors and previous term birth weight, these are: (1) estimating fetal weight by clinical palpation, [1,2,3,4,5,6,7,8,9] (2) performing obstetrical ultrasonography to estimate fetal weight based on fetal biometric measurements, [3,4,5,6,7,8,9] (3) asking the mother to make her own estimate of fetal weight, [1,2,3,4,5] (4) quantitatively assessing relevant maternal and pregnancy-specific characteristics, [15,19] and (5) using equations that combine information from maternal and pregnancy-specific characteristics with fetal ultrasonographic measurements. [20,21] Of all these methods, it has been shown previously that the latter technique of combining maternal and pregnancy-specific characteristics with ultrasonographic fetal measurements provides the most accurate birth weight predictions. [20]

This study evaluated the predictive value of prior term birth weight as a predictor of subsequent birth weight. The correlation between term birth weight in prior and subsequent pregnancies was 0.39. The mean absolute error associated with such birth weight predictions was ±330 g [11.6 oz] (±9.6%). When corrections were made for differences in both the gestational age at delivery and fetal gender, these prediction errors diminished to ±291 g [10.3 oz] (±8.4%). Of these two additional factors, correcting for the difference in gestational age was by far the more significant (Table 2). By comparison, previously published mean absolute errors for term fetal weight predictions have been reported for maternal self-estimates as ±305-402 g, [1,2,3,4,5] for clinical palpation as ±277-336 g, [1,2,3,4,5,6,7,8,9] for quantitative assessment of maternal and pregnancy-specific characteristics as ±267-296 g, [15,19] for obstetrical ultrasonographic fetal biometry as ±285-564 g, [3456789] and for combined maternal characteristics-ultrasonographic methods as ±259 g. [20]

Previously, it has been shown that women tend to repeat similar birth weight and gestational age patterns in successive pregnancies. [22] This provides multiparous women with a distinct advantage over under-informed clinicians who attempt to estimate fetal weight. Multiparous women not only know the birth weight of their prior offspring, but they also typically know two other pieces of information that are necessary to optimally predict their current fetus's weight: the gender of their prior offspring and their gestational age at the prior delivery. In large part, this may explain why they are able to estimate the birth weight of subsequent fetuses reasonably.

Caution must be exercised when using the prior term birth weight method to estimate subsequent term fetal weights. Firstly, the approach is applicable only to multiparas and cannot be applied to primigravidas, who comprise a large fraction of pregnant women in most industrialized countries. The study also was conducted in non-diabetic, non-hypertensive women; the presence of uncontrolled diabetes mellitus fosters a predictable disposition toward fetal overgrowth, [11] and fetal weight under these circumstances depends strongly on the success of glycemic control during pregnancy. Analogously, chronic hypertension and pre-eclampsia both predispose to diminished fetal weight gain, thereby requiring estimates to be adjusted by 161 g when pregnancies involve chronic maternal hypertension and 120 g when they involve mild pre-eclampsia. [12,13] Thus, if either a prior or subsequent pregnancy is complicated by gestational diabetes, chronic hypertension or pre-eclampsia, the correlation between prior and subsequent term birth weights can be expected to diminish.

Additionally, the usefulness of prior term birth weights for predicting subsequent ones depends on gravidas consistently abstaining from cigarette smoking and living at approximately the same altitude above sea level during both pregnancies. Term birth weight systematically declines by 12 18 g per cigarette consumed per day during pregnancy (i.e., a one pack per day smoker will have an average birth weight reduction of 240 360 g at term), [23,24] and by 10-14 g per 100 m elevation above mean sea level. [25,26,27] Thus, if either cigarette consumption or the mean ambient altitude of residence changes between pregnancies, the correlation between birth weights can be expected to diminish.

The results of this study show that the correlation between term birth weights in prior and subsequent pregnancies and the prediction errors associated with these estimates is the same or better than for multiparous women who make their own estimations of fetal weight in subsequent pregnancies. [1,2,3] Since multiparous women are not blinded to the weight of their prior offspring, our findings suggest that multiparas estimate the birth weight of their current fetus by merely guessing a birth weight that is close to a prior one after making appropriate mental adjustments for known differences in gestational age and fetal gender between pregnancies (if known). Thus, since multiparous women routinely possess this information, it is not unexpected that they can make birth weight predictions with reasonable accuracy in subsequent pregnancies. However, the mean absolute errors associated with maternal self-estimates of fetal weight are typically greater than 10%. Thus, for a fetus having an actual weight of 4,000 g, maternal estimates can be expected to routinely range from 3,600 g (normal weight) to 4,400 g (fetal macrosomia). Because of this degree of inaccuracy and the wide variability associated with such maternal self-estimations, their utility is severely limited for the purpose of assisting with clinical decision-making.

If clinicians are provided with identical information to multiparous women, the findings of this study show that they can estimate term birth weight accurately to within ±291 g (±8.4%). This level of accuracy is superior to the estimates that multiparous women have been shown to make in virtually all reports in the medical literature. Accordingly, it can be concluded that there is no added value to obtaining maternal self-estimates of fetal weight beyond what can be obtained by employing other fetal weight prediction methods, including clinicians using routinely obtainable pregnancy-specific information.

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